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No.	Delivered	From	Subject	Lines
1	Jan 4 13:14	P.HOBBS	** ONR P.I. Report (PO) ***	201

Command? read 1

Posted: Mon, Jan 4, 1993 1:13 PM EST Msg: LGJD-5503-1780
From: P.HOBBS
To: ONR.OAP.DIV (rec)
CC: P.HOBBS/OMNET
Subj: ** ONR P.I. Report (PO) ***

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SCIENCEnet Mailbox: P.HOBBS/OMNET

"Airborne Studies of Ocean-Particle-Cloud Interactions"

Research Goals:
Our research goal was to use our instrumented Convair C-131A research aircraft to characterize effects of leads in the arctic environment.

Objectives:
Our objectives were to measure the lead signatures by remote sensing, measure emissions and fluxes from leads, determine effects of lead emissions on clouds, and to characterize arctic haze.

Approach:
Our approach was to fly over the pack ice, north of Deadhorse Alaska, detect leads with open water and conduct in situ measurements, sampling and remote sensing measurements. The measurements included determining the concentrations of droplets, ice crystals, and cloud condensation nuclei near leads. The sampling included pumping whole air samples into stainless steel canisters for analysis for two biologically generated gases, DMS(di-methyl-sulfide, a potential source of particles that can serve as water condensation nuclei and alter the properties of clouds) and for $CHBr_3$ (bromoform, a gas with potential for destruction of stratospheric ozone). During flights over leads we measured the lead remote sensing signatures, recording video images, optical backscatter using a downward pointing lidar, and surface radiative temperature using a narrow field of view, long-wave, infra-red radiometer (2 degrees field of view, 8-12 micron wavelength interval) . During our flights near the leads, we recorded the air temperature and wind vector as a function of altitude to measure energy flux from the leads. Portions of several flights were used

to measure arctic haze concentration, using an integrating nephelometer, and haze concentration and composition determined from filter samples of the aerosol particles. Portions of several flights were devoted to measurement of ice crystal concentration in clear air and the effect of crystals on transfer of infra-red energy within the atmosphere. Portions of several flights were used to measure the incident and reflected solar radiation as a function of angle and wavelength from ice and the upper surface of clouds.

Tasks Completed:
During the fiscal year we planned the experiment, conducted the experiment, and performed preliminary data analysis as well as participated in the LEADEX Workshop at Applied Physics Laboratory at the University of Washington and met with Dr. Robert Abbey of ONR at our campus offices.

Scientific Results:
Our scientific results from partial analysis of our data include:
1. We found that the IR radiative thermometer appears to be superior to lidar in detecting and characterizing leads. We found ice-surface temperature differences between the up-wind and down-wind sides of a lead. (See figure 1)
2. Concentrations and emissions of DMS were low at this time of the year. We found concentrations of DMS to be 3 pptv or less (minimum detectable levels of DMS are about 1 pptv) with differences between up-wind and down-wind sampling found to be approximately 1 pptv. We occasionally measured 5-10 pptv of DMS, but only over areas with substantial open water near Barrow.
3. We found that CHBr3 levels were 8-15 pptv below 1000 feet and decreased from approximately 5 pptv at 2,000 feet to approximately 2 pptv at 30,000 feet, as shown in figure 2.
4. We found that the heat flux from a single lead, determined from a surface drag approach in which the surface heat flux is related to the wind speed and the potential temperature difference between the surface and a measurement height was about 40 watts per meter squared. The heat flux was also calculated from the measured change in the temperature versus altitude over time for the lowest few hundred meters utilizing the thermodynamic energy equation, assuming that we can neglect radiative flux divergence. The result of this calculation was 30 watts per meter squared. The two results are in reasonable agreement.
5. The concentrations of ice crystals in clear air were very low and undetectable in replica sampling and our in situ optical probe. Ice crystal optical backscattering was detected in our lidar. We have not examined our radiative flux divergence data.
6. The concentration of Arctic haze was low as measured by both our integrating nephelometer and by filter sampling. We were able to detect the pollution plume from the industry concentrated near Deadhorse by elevated concentrations of condensation nuclei and of nitrogen dioxide. The Deadhorse plume was not detectable in optical scattering as measured either by

the integrating nephelometer or by the lidar. The low optical scattering by the plume is due to low emissions of particles larger than approximately 0.15 micron.

7. The incident and surface reflected optical radiation field was measured from our aircraft by Drs. Michael King and S. C. Tsay (both of NASA Goddard) at discrete wavelengths between 0.5 and 2.2 micron. They found that the ice surface is quite isotropic (Lambertian) with little limb brightening, even at 1.6 and 2.2 micron. There were unexpected differences in the reflectivity of sea ice between the wavelengths of 1.22 and 1.27 micron, probably due to differences in the refractive index of ice between these two wavelengths. Dr. King and his co-workers expect to complete analysis of data and prepare scientific papers in the next six months.

Accomplishments:
Our accomplishments include successfully acquiring a large quantity of data that will be useful to develop remote sensing signatures for leads. This will allow improved interpretation of satellite data. Our lead thermal flux measurements may provide some insight into the role of the leads as a source of heat and moisture into the arctic atmosphere. Our measurements were able to characterize the concentrations of DMS and $CHBr_3$. Both gases have biological sources but the emissions of DMS appear to be very low at this time of year. $CHBr_3$ emissions are significant and our concentrations measurements illustrate the role of the surface inversion in confining emission to the surface layer. The infra-red radiative thermometer proved to be useful to detect leads and to indicate the thickness of ice that has formed in the lead. Both the lead signature data and the ability of the infra-red radiative thermometer to detect and characterize leads will be useful to Navy operations in polar regions.

** Figures will be sent to ONR **

ONR-Sponsored Publications
C - Sheridan, P. J., R. C. Schnell, T. J. Conway and R. J. Ferek. 1992: Aerosol Chemistry Measurements over the Beaufort Sea During AGASP-IV/LEADEX, April 1992, Proceedings of the Fifth International Conference on Arctic Air Chemistry, ed. by N. Z. Heidam, 7 - 10 September 1992, Copenhagen, Denmark.

Statistics
0 Papers published, refereed journals
0 Papers submitted, refereed journals
0 Books or chapters published, refereed publication
0 Books or chapters submitted, refereed publication
0 Invited presentations
1 Contributed presentations
0 Technical reports and papers, non-refereed journals
0 Undergraduate students supported
0 Graduate students supported
0 Post-docs supported
1 Other professional personnel supported

EEO/Minority Support

0 Female grad students
0 Minority grad students
0 Asian grad students
0 Female post-docs
0 Minority post-docs
0 Asian post-docs

Patents and awards

Influences:

1. Arya, S.P.S. 1988: Introduction to Micrometeorology, Academic Press, San Diego.

2. Arya, S.P.S. 1977: Suggested Revisions to Certain Boundary Layer Parameterization Schemes Used in Atmospheric Circulation Models, Mon.Weather Rev., 105, 215-227.

3. Chen, C. and W.R. Cotton 1987: The Physics of the Marine Stratocumulus-capped Mixed Layer. J.Atmos.Sci., 44, 2951-2977.

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Action?

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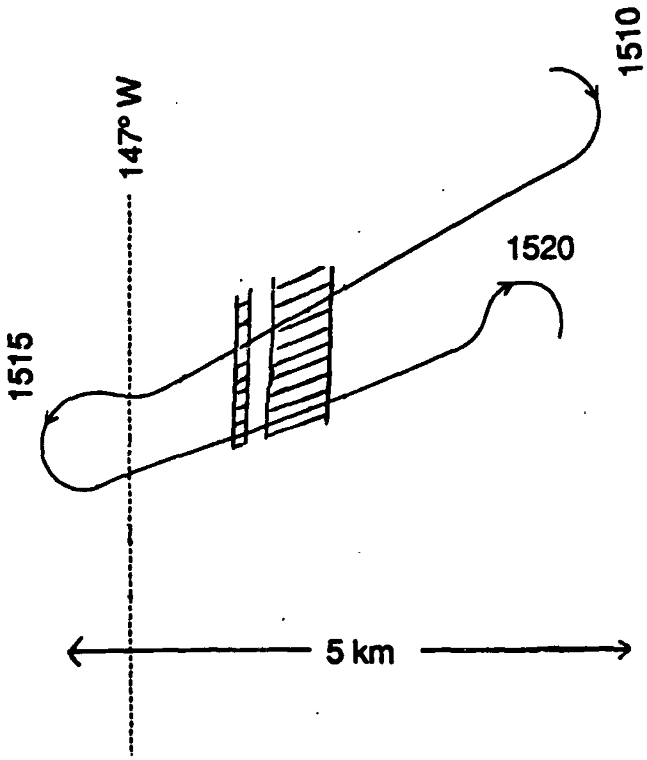
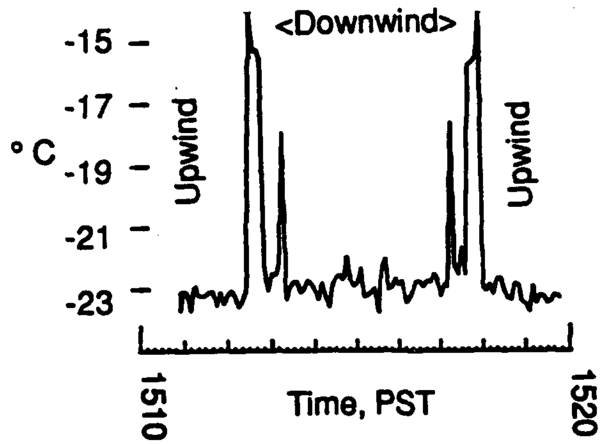


Flight Track U of Washington aircraft, 4/14/92, 1510-1520 PST. The location of frozen leads is indicated by cross hatching.



LWIR radiative surface temperature versus time from 100 m altitude.

Figure1.
Flight track of University of Washington aircraft for 1510-1520 PST on 14 April, showing lead location (cross hatched region @ 73.2° N, 146.9° W). Also shown in the trace of indicated temperature from a 2° FOV, 8-12 μm radiometer. The indicated IR surface temperature trace detects the frozen leads, measures the ratiative temperatures of the ice on each side of the leads and detects differences in temperature across the frozen leads. The eastern edge of the lead is warmer (indicating thinner ice) than the western edge indicating that the wind was from the East during freezing. The ice surface was warmer by about 0.5° C on the Western side of the lead compared to the Eastern side, indicating that the downwind plume from the lead transfered heat to the downwind ice surface.

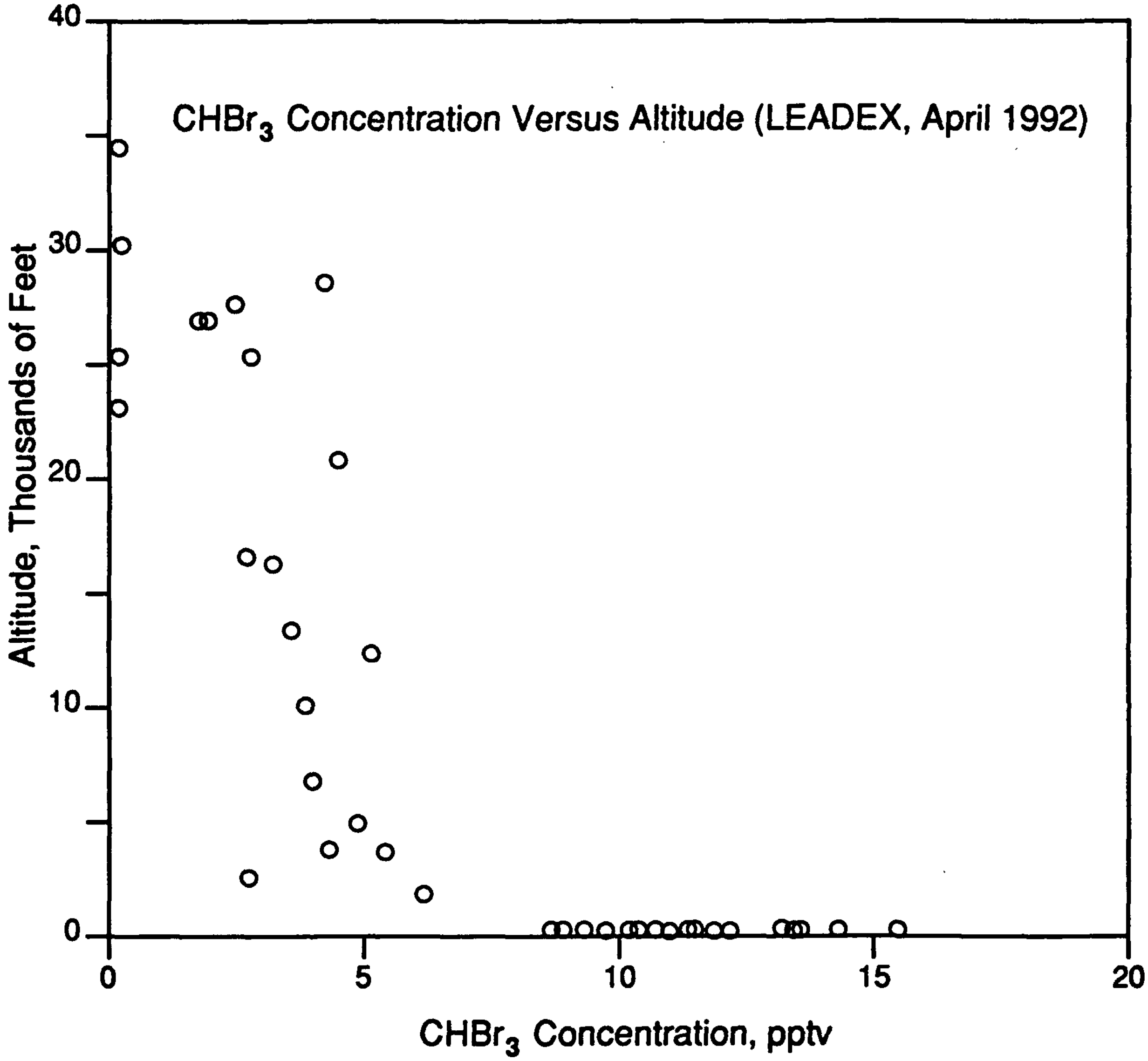


Figure 2.
$CHBr_3$ concentrations as a function of altitude as sampled by the University of Washington and by the NOAA P-3 during LEADEX in April, 1992. Whole air samples were collected in stainless steel canisters and analyzed by R. A. Rasmussen of the Oregon Graduate Institute. Our interpretation is that the source is ice alge at the surface with emissions from leads. The mixing through the bottom thousand feet is retarded by strong surface inversions commonly found at this time of year. Concentration decreases slowly with increasing altitude as expected with photo-disasociation. We expect that $CHBr_3$ is not responsible for significant stratospheric ozone destruction because of the relatively short lifetime of this species in the troposphere.